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Mapping of frequently flood affected villages in Eastern Hindukush Region, Pakistan

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Abstract

In order to locate and map the villages in the Eastern Hindu Kush region that are frequently affected by flooding, this research offers a rigorous analysis that combines point level geocoding techniques with an extensive literature assessment. In Eastern Hindu Kush region, flooding is a frequent and destructive natural calamity that affects infrastructure and populations. This study uses information from the literature and geospatial data to identify the communities that are most vulnerable in order to solve this problem. In order to precisely pinpoint these communities on digital maps, this research uses advanced geocoding techniques, which offers insightful information for activities aimed at mitigating and preparing for disasters. This study provides an integrated picture of the flood-prone regions in Eastern Hindu Kush region by merging historical flood data with academic research findings. This allows for targeted interventions and resource allocation for disaster management and community resilience.

1. Introduction

Floods are thought to be the most destructive hazard on a global scale (Rehman and Khan 2013; Qasim et al. 2016). Approximately half of all hydrometeorological disasters are related to flooding (Halgamuge and Nirmalathas 2017). The frequency and intensity of catastrophic floods have grown recently as a result of climate change, and they have become even more intense as a result of the encroachment of human activity along rivers (Khalid et al., 2018). In general, strong rains (Tariq and Giesen 2012; Mahmood et al. 2016a, b), dam breaches, river embankments, and the quickly melting of snow and glaciers (Jonkman et al. 2008; Sajjad et al. 2019) are the main causes of floods. Similarly, unexpected modifications to land cover and the fast expansion of communities inside floodplains aggravate floods even more (Syvitski and Brackenridge 2013; Iqbal et al. 2018).

The Eastern Hindukush region in Pakistan, characterized by its diverse topography and intricate river systems, faces the recurrent challenge of floods. This natural disaster often results from a combination of factors, including intense monsoon rains, glacial meltwaters and rapid snowmelt from the towering peaks (Gupta and Sah 2008). As watercourses navigate through steep terrains, the susceptibility to flash floods and riverine inundation increases, impacting both rural and urban communities (Hunter et al. 2005; Ali 2007). The socio-economic and environmental implications of floods in this region underscore the need for comprehensive understanding and effective mitigation strategies to safeguard lives and livelihoods.

2. Method

Frequently flooded villages in Pakistan's Eastern Hindukush region are mapped using an approach that incorporates information from a comprehensive literature assessment drawn from a variety of sources, including scholarly articles and newspapers. In order to pinpoint patterns, trends, and critical elements influencing a given village's susceptibility to periodic floods, a thorough analysis of past flood records, meteorological data, and scientific research was conducted in the first phase. This examination of the literature made it easier to identify high-risk areas, important environmental indicators, and socioeconomic variables that increase the impact of floods on nearby towns. Additionally, it gave rise to a basis for comprehending the dynamics of flood events, encompassing the part played by local topography, climate, and land use practices.

Point-level geocoding was used in the process to shift to a spatial analysis approach after the literature evaluation. This required converting textual data—like village names that are cited in the literature—into spatial coordinates, or latitude and longitude. The places that

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are commonly impacted by flooding were shown by plotting these geocoded points on a digital map using Geographic Information System (GIS) tools. A more precise identification and visualization of susceptible communities was made possible by the incorporation of geospatial data, which also let stakeholders and decision-makers evaluate the geographical distribution of flood-prone regions and rank intervention solutions.

2.1. Study Area

The districts of Chitral, Upper Dir, Lower Dir, and Swat make up Pakistan's Eastern Hindu Kush region. Geographically, it covers the area between 34°34'11" and 36°54'30" North Latitude and 71°11'56" to 73°52'5" East Longitude. A fourth region in Pakistan known as the Hindu Raj would be included in a comprehensive depiction of the Hindu Kush.

A long, twisting chain of mountains, including steep peaks like Mount Darkot and Buni Zom, which strike southward from the Lupsuk Peak in the Eastern region and continue to the Kabul River, forms this area. Hindu Kush includes this mountain range (Mahmood, 2019).

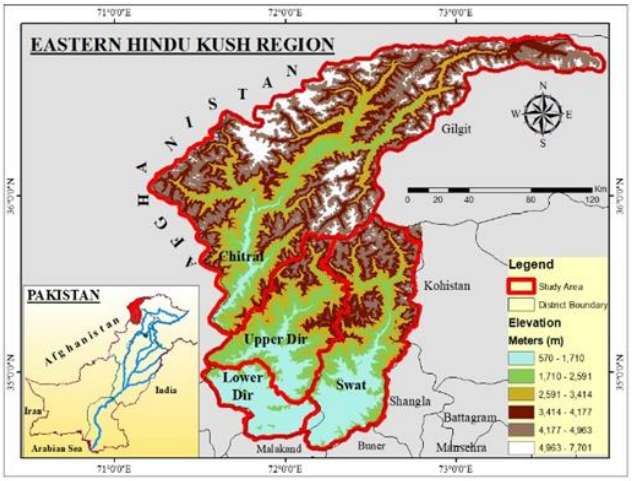
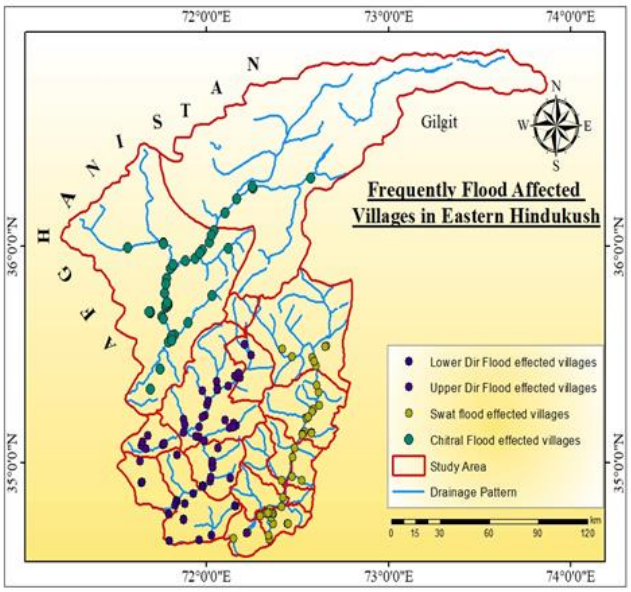


Figure 1. Location of study area.

The research region has cold to warm summer temperatures, with minimums of 16 °C and maximums of 32 °C. From December to February, the temperature drops below freezing. The hallmark of the winter season is the presence of snowfall. The difference between the minimum and greatest amounts of rainfall in December and March was 823 mm and 2149 mm, respectively. Snow usually begins to fall in November and moves southward when the temperature drops in December. Depending on the height, snow melting continues into March (Mahmood and Rahman, 2019).

3. Results

The Eastern Hindukush Region of Pakistan's inventory map of villages impacted by flooding shows a worrying pattern of repeated flood damage over the previous ten years, especially in tehsils like Kalkot, Chitral, Dir, Wari, Babuzai, Bahrain, and Timergara. These places are particularly vulnerable to floods due to a number of variables. First off, during periods of intense rainfall, the region is vulnerable to flash floods due to its geography, which is made up of steep hills and river valleys. The risk of riverbanks overflowing and surrounding settlements being inundated is increased by the mountainous topography, which speeds up water runoff. Furthermore, communities frequently settle in flood-prone locations since there are few other viable places to live, which makes the vulnerability worse owing to improper land-use planning and zoning rules.



Furthermore, insufficient infrastructure in these tehsils exacerbates the effects of floods. Villages that lack sturdy drainage systems and flood prevention measures are vulnerable to harm during severe weather conditions. Older or badly maintained infrastructure frequently fails to resist the power of flooding, with disastrous results for the impacted populations. Moreover, soil erosion is a result of deforestation and poor land management, which lowers the ground's natural capacity to absorb excess water and raises the risk of floods. The confluence of these variables underscores the pressing requirement for all-encompassing flood alleviation tactics, encompassing the adoption of sustainable land-use methodologies, enhanced infrastructure, and community education initiatives, in order to protect the Eastern Hindukush Region against the catastrophic consequences of periodic flooding.

4. Discussion

Over the past ten years, the Eastern Hindukush Region of Pakistan—which includes tehsils like Kalkot, Chitral, Dir, Wari, Babuzai, Bahrain, and Timergara—has seen an alarming trend of recurring flood devastation. The creation of an inventory map that details the different elements that contribute to these places' susceptibility is crucial to comprehending the effects of floods on these settlements. The geology of the area, which is marked by rocky terrain and steep slopes, is one important component that enhances runoff during periods of heavy rainfall and speeds up the escalation of floods. The issue is made worse by the communities' poor construction of drainage systems and flood prevention

measures, which makes them very vulnerable to flooding.

By itself, a hazard is not always disastrous. Any danger might have catastrophic effects on a population that is already vulnerable. One of the primary worldwide priorities is disaster resilience, which can only be achieved by reducing the vulnerability of vulnerable groups (Sarker et al., 2022). Vulnerability management helps communities that are vulnerable become resilient ones. According to Nasiri et al., (2016), vulnerability is a relationship that varies in both time and space between exposure and susceptibility of people, groups, structures, and objects. In addition to other demographic and environmental trends that have consistently exposed more people to natural hazards, the causes include population density, population growth, poverty, gender, age, and physical disability.

5. Conclusion

According to the research's findings, it will be easier to distinguish between high- and low-risk places by looking at the spatiotemporal pattern of flood-affected villages between 2010 and 2020. As a useful method for identifying flood risk from historical data, our analysis suggests using spatial statistics between 2010 and 2020. The spatial statistical approach is also demonstrated by the findings; with careful application, this method may be very helpful in identifying and analyzing flood mitigation strategies at the local level. The study has several limitations that should be noted, such as the fact that this analysis did not take into account anthropogenic or natural flood-influencing elements. On the basis of the categorical variables, the inquiry has been conducted. Within the subdivision, the risk zones are determined by how well the flood hotspots are identified. As such, mitigating actions must be considered in order to lower the danger of flooding hazards.

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